Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

Sample Name	Location	Type	*n*	δD (‰, VSMOW)	1σ	$\delta^{13}C$ (‰, VPDB)	1σ	Δ_{18}	1σ	T_{18} (°C)	1σ	Measured T(°C)	C_1/C_2+C_3	
Lobo 4743D	Juan de Fuca Ridge	HV	1	-97.4	0.11	-49.02	0.005	1.4	0.25	365	50			
Bastille 4743-1	Juan de Fuca Ridge	HV	1	-96.1	0.14	-50.08	0.005	1.7	0.27	305	40			
Bastille 4743-B	Juan de Fuca Ridge	HV	1	-96.3	0.12	-50.36	0.005	1.7	0.25	305	37			
K7	Nisyros (Greece)	HV	1	-123.4	0.12	-23.51	0.005	1.0	0.28	444	79			2459
Favare Grande	Pantelleria (Sardinia)	HV	1	-129.7	0.12	-18.24	0.004	1.4	0.25	364	49			4889
Washburn 1	Yellowstone (WY, USA)	HV	1	-216.3	0.18	-24.79	0.007	1.5	0.23	347	45			
Washburn 0	Yellowstone (WY, USA)	HV	1	-217.6	0.14	-25.19	0.006	0.6	0.24	578	109			
Chimaera S3	Chimaera (Turkey)	ZS	1	-115.8	0.11	-12.18	0.004	2.2	0.25	238	28			
Chimaera S2	Chimaera (Turkey)	ZS	1	-115.6	0.10	-11.95	0.005	2.3	0.24	234	26			
PT-11359-10	Northeastern Onshore Basin (Brazil)	TCA	1	-138.4	0.13	-39.66	0.005	3.4	0.21	140	13			
PT-11359-11	Northeastern Onshore Basin (Brazil)	TCA	1	-165.0	0.13	-42.12	0.005	3.1	0.23	165	16			
PT-11359-12	Northeastern Onshore Basin (Brazil)	TCA	1	-175.1	0.12	-47.84	0.004	3.8	0.23	119	13			
PT-11359-13	Northeastern Onshore Basin (Brazil)	TCA	1	-128.5	0.12	-38.68	0.004	2.8	0.24	182	19			
PT-11359-14	Northeastern Onshore Basin (Brazil)	TCA	1	-115.8	0.12	-34.91	0.005	2.5	0.23	211	21			

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

PT-11359-15	Southeastern Offshore Basin (Brazil)	TCA	1	-189.1	0.13	-45.59	0.005	3.0	0.22	172	16
PT-11359-16	Southeastern Offshore Basin (Brazil)	TCA	1	-171.7	0.14	-45.17	0.004	4.0	0.24	108	12
PT-11359-17	Southeastern Offshore Basin (Brazil)	TCA	1	-149.0	0.12	-38.36	0.005	2.7	0.25	191	21
PT-11359-18	Southeastern Offshore Basin (Brazil)	TCA	1	-174.9	0.11	-41.97	0.005	3.7	0.23	127	13
PT-11359-19	Southeastern Offshore Basin (Brazil)	TCA	1	-137.0	0.12	-38.68	0.005	2.5	0.22	210	21
PT-11359-20	Southeastern Offshore Basin (Brazil)	TCA	1	-140.7	0.12	-38.31	0.004	3.1	0.24	165	17
PT-11359-21	Southeastern Offshore Basin (Brazil)	TCA	1	-140.7	0.10	-38.32	0.004	2.3	0.25	233	27
PT-11359-22	Southeastern Offshore Basin (Brazil)	TCA	1	-140.9	0.12	-38.32	0.005	3.1	0.24	161	17
PT-11359-28	Southeastern Offshore Basin (Brazil)	TCA	1	-121.7	0.12	-32.61	0.004	3.0	0.25	171	19
PT-11359-29	Southeastern Offshore Basin (Brazil)	TCA	1	-136.1	0.13	-34.33	0.005	2.0	0.26	266	32
PT-11359-30	Southeastern Offshore Basin (Brazil)	TCA	1	-121.4	0.13	-30.22	0.004	2.4	0.24	217	23
PT-11359-31	Southeastern Offshore Basin (Brazil)	TCA	1	-145.1	0.25	-38.25	0.008	2.2	0.27	240	30

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

PT-11359-32	Southeastern Offshore Basin (Brazil)	TCA	1	-150.9	0.07	-39.05	0.005	2.7	0.31	196	26	
PT-11359-33	Southeastern Offshore Basin (Brazil)	TCA	1	-145.2	0.35	-38.37	0.005	2.3	0.33	230	34	
PT-11359-34	Southeastern Offshore Basin (Brazil)	TCA	1	-148.8	0.16	-38.39	0.004	2.8	0.31	185	25	
SH1	Mars Basin (Gulf of Mexico)	TCA	1	-199.2	0.10	-56.77	0.005	3.5	0.21	135	13	6
SH2	Mars Basin (Gulf of Mexico)	TCA	1	-188.0	0.09	-63.61	0.005	3.6	0.24	129	14	16
SH3	Ram Powell Field (Gulf of Mexico)	TCA	1	-173.9	0.11	-54.41	0.005	4.0	0.24	107	12	12
SH4	Ram Powell Field (Gulf of Mexico)	TCA	2	-178.9	0.01	-57.16	0.022	3.8	0.03	121	2	13
SH5	Ram Powell Field (Gulf of Mexico)	TCA	1	-177.7	0.08	-56.40	0.006	4.1	0.24	103	11	11
EM1	Julia Field (Gulf of Mexico)	TCA	1	-272.0	0.12	-59.16	0.004	2.9	0.23	180	18	
EM2	Julia Field (Gulf of Mexico)	TCA	1	-300.2	0.13	-57.73	0.005	3.7	0.25	123	14	
EM3	Hadrian North (Gulf of Mexico)	TCA	1	-237.0	0.12	-55.99	0.005	4.3	0.23	95	11	3
EM4	Offshore California	TCA	1	-186.6	0.13	-47.69	0.005	4.0	0.22	110	11	11
EM5	Offshore California	TCA	1	-153.8	0.13	-37.57	0.004	2.7	0.25	194	21	7

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

Jackpot	Santa Barbara Basin	TCAS	1	-191.8	0.13	-48.19	0.004	4.0	0.24	107	12	119
Super Seep	Santa Barbara Basin	TCAS	1	-190.8	0.11	-48.27	0.005	3.7	0.23	123	13	38
Holly	Santa Barbara Basin	TCAS	1	-206.5	0.13	-45.86	0.004	2.8	0.24	187	20	
LaGoleta 4543	Santa Barbara Basin	TCAS	1	-191.7	0.13	-42.52	0.004	2.3	0.25	233	26	11
Tonya	Santa Barbara Basin	TCAS	1	-173.9	0.12	-43.58	0.005	2.9	0.25	174	19	18
Patch_J2596	Santa Barbara Basin	TCAS	1	-165.8	0.13	-41.92	0.005	2.2	0.25	239	27	11
Farrar bottom	Santa Barbara Basin	TCAS	1	-185.6	0.12	-44.65	0.005	3.7	0.26	127	15	43
Shane Seafloor	Santa Barbara Basin	TCAS	1	-197.6	0.13	-49.22	0.005	3.4	0.26	141	16	51
Near Brian Seafloor	Santa Barbara Basin	TCAS	1	-187.0	0.14	-43.61	0.004	4.3	0.23	93	11	73
Brian Bottom	Santa Barbara Basin	TCAS	1	-184.8	0.15	-42.98	0.004	4.1	0.26	104	13	48
Shane Surface	Santa Barbara Basin	TCAS	1	-197.6	0.13	-49.51	0.005	4.4	0.25	87	11	75
J2-739-2	Santa Barbara Basin	TCAS	1	-199.1	0.13	-48.10	0.005	2.5	0.25	210	25	25
J2-740-1	Santa Barbara Basin	TCAS	2	-173.2	0.12	-41.80	0.004	1.7	0.18	298	25	9
J2-741-1	Santa Barbara Basin	TCAS	1	-186.6	0.13	-43.00	0.004	2.1	0.26	250	32	13
J2-742-1	Santa Barbara Basin	TCAS	1	-190.9	0.14	-46.90	0.005	6.5	0.30	116	17	1545
EM6	Sliepner Vest (Norwegian North Sea)	TCN	1	-204.9	0.12	-40.08	0.005	2.4	0.24	219	24	6
EM7	Sliepner Vest (Norwegian North Sea)	TCN	1	-214.9	0.11	-41.25	0.005	2.3	0.24	232	25	6

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

EM8	Sliepner Vest (Norwegian North Sea)	TCN	1	-203.5	0.11	-39.80	0.004	2.8	0.23	185	19	6
EM9	Sliepner Vest (Norwegian North Sea)	TCN	1	-206.6	0.14	-40.31	0.004	2.8	0.20	185	16	6
EM10	Sliepner Vest (Norwegian North Sea)	TCN	1	-194.5	0.14	-38.20	0.004	2.6	0.24	203	22	7
EM11	Rotliegend (Germany)	TCN	1	-115.0	0.12	-26.20	0.005	2.2	0.25	239	28	63
EM12	Rotliegend (Germany)	TCN	1	-113.3	0.12	-25.54	0.004	2.3	0.26	230	27	66
EM13	Rotliegend (Germany)	TCN	2	-115.0	0.10	-26.24	0.015	2.6	0.35	203	31	63
EM14	Rotliegend (Germany)	TCN	1	-113.8	0.12	-25.83	0.005	2.3	0.25	231	26	64
EM15	Rotliegend (Germany)	TCN	1	-113.5	0.12	-25.42	0.009	2.5	0.24	206	22	68
EM16	Rotliegend (Germany)	TCN	1	-112.0	0.12	-26.18	0.004	2.2	0.23	244	26	54
EM17	Rotliegend (Germany)	TCN	1	-112.1	0.12	-26.10	0.005	2.0	0.26	267	33	52
EM18	Rotliegend (Germany)	TCN	1	-111.5	0.12	-25.94	0.005	2.7	0.24	193	20	54
EM19	Rotliegend (Germany)	TCN	1	-111.5	0.12	-26.07	0.004	2.5	0.25	212	24	57
EM20	Rotliegend (Germany)	TCN	1	-109.8	0.11	-25.63	0.004	3.4	0.27	144	17	53
Bakken-1	Bakken Shale (South Dakota, USA)	TUA	1	-280.4	0.12	-49.58	0.005	3.4	0.24	140	15	
Bakken-2	Bakken Shale (South Dakota, USA)	TUA	1	-279.7	0.09	-49.82	0.004	3.2	0.21	154	14	

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

Bakken-3	Bakken Shale (South Dakota, USA)	TUA	1	-252.7	0.13	-48.34	0.005	2.4	0.24	221	24	
Bakken-4	Bakken Shale (South Dakota, USA)	TUA	1	-248.7	0.12	-48.43	0.005	2.3	0.24	231	25	
Bakken-5	Bakken Shale (South Dakota, USA)	TUA	1	-252.0	0.13	-48.39	0.004	2.9	0.27	179	21	
Bakken-6	Bakken Shale (South Dakota, USA)	TUA	1	-273.7	0.12	-49.92	0.005	2.6	0.23	197	20	
Bakken-7	Bakken Shale (South Dakota, USA)	TUA	1	-284.9	0.12	-49.17	0.005	2.5	0.22	213	20	
Bakken-8	Bakken Shale (South Dakota, USA)	TUA	1	-269.8	0.14	-48.92	0.005	2.8	0.27	184	22	
Bakken-9	Bakken Shale (South Dakota, USA)	TUA	1	-267.3	0.13	-39.76	0.005	1.7	0.25	302	38	
EM21	Eagleford Shale (Texas, USA)	TUA	1	-226.8	0.13	-45.73	0.005	2.1	0.25	248	29	3
EM22	Eagleford Shale (Texas, USA)	TUA	2	-225.1	0.18	-45.5	0.19	2.8	0.53	184	40	5
EM23	Eagleford Shale (Texas, USA)	TUA	1	-244.8	0.13	-46.88	0.005	1.4	0.22	345	43	4
EM24	Eagleford Shale (Texas, USA)	TUA	1	-243.9	0.13	-46.26	0.005	2.4	0.22	221	22	4
EM25	Eagleford Shale (Texas, USA)	TUA	1	-245.3	0.12	-47.00	0.005	1.5	0.22	329	39	4

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

EM26	Eagleford Shale (Texas, USA)	TUA	1	-180.1	0.12	-43.03	0.005	2.5	0.25	213	24	
EM27	Eagleford Shale (Texas, USA)	TUN	1	-168.0	0.13	-40.10	0.005	1.1	0.25	428	65	5
EM28	Eagleford Shale (Texas, USA)	TUN	1	-167.9	0.12	-40.27	0.002	2.5	0.23	208	21	5
EM29	Eagleford Shale (Texas, USA)	TUN	2	-167.6	0.03	-40.1	0.08	2.1	0.22	251	28	6
EM30	Eagleford Shale (Texas, USA)	TUN	1	-151.4	0.11	-38.09	0.005	2.7	0.25	189	21	24
EM31	Eagleford Shale (Texas, USA)	TUN	2	-161.8	0.35	-39.9	0.13	3.0	0.32	169	25	
EM32	Eagleford Shale (Texas, USA)	TUN	1	-150.0	0.13	-37.70	0.005	2.3	0.25	232	26	
SH6	Appalachian Basin (Pennsylvania, USA)	TUN	1	-151.3	0.11	-31.82	0.005	3.1	0.25	161	18	
SH7	Appalachian Basin (Pennsylvania, USA)	TUN	1	-198.0	0.12	-44.25	0.005	2.6	0.24	203	22	
SH8	Appalachian Basin (Pennsylvania, USA)	TUN	1	-189.2	0.12	-43.28	0.005	2.6	0.24	198	21	
SH9	Appalachian Basin (Pennsylvania, USA)	TUN	1	-226.7	0.12	-47.44	0.004	1.2	0.25	403	59	

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

EM33	Marcellus Shale (Pennsylvania, USA)	TUN	1	-199.5	0.12	-44.09	0.004	2.2	0.25	245	26	**48**	4
EM34	Marcellus Shale (Pennsylvania, USA)	TUN	1	-199.8	0.14	-44.12	0.005	2.7	0.24	191	20		
EM35	Marcellus Shale (Pennsylvania, USA)	TUN	1	-158.6	0.11	-27.05	0.004	3.2	0.22	155	15		
L-1	Longmaxi Shale (China)	TUN	1	-140.9	0.14	-30.37	0.005	3.1	0.24	162	17		144
L-2	Longmaxi Shale (China	TUN	1	-134.0	0.13	-35.54	0.004	2.6	0.23	199	20		252
L-3	Longmaxi Shale (China	TUN	1	-136.0	0.13	-33.02	0.005	2.5	0.25	206	22		1489
EM36	Diana/Hoover Fields (Gulf of Mexico)	M	1	-200.4	0.13	-58.47	0.004	4.5	0.25	85	11		10
EM37	Diana/Hoover Fields (Gulf of Mexico)	M	1	-204.9	0.11	-59.07	0.004	4.4	0.22	88	10		13
EM38	Diana/Hoover Fields (Gulf of Mexico)	M	1	-202.9	0.13	-60.37	0.005	3.8	0.24	118	13		15
EM39	Diana/Hoover Fields (Gulf of Mexico)	M	1	-195.0	0.13	-56.27	0.005	4.9	0.24	70	9		
EM40	Diana/Hoover Fields (Gulf of Mexico)	M	1	-194.9	0.13	-56.38	0.004	5.2	0.23	57	8		
EM41	Diana/Hoover Fields (Gulf of Mexico)	M	1	-192.5	0.14	-57.05	0.004	5.3	0.25	52	9		16

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

EM42	Diana/Hoover Fields (Gulf of Mexico)	M	1	-200.5	0.14	-57.80	0.005	4.5	0.24	86	11		12
S-1	Songliao Basin (China)	M	1	-246.7	0.13	-61.86	0.005	6.9	0.25	5	6	**25**	129
S-2	Songliao Basin (China)	M	1	-249.1	0.15	-58.99	0.005	10.2	0.25	-77	8	**32**	1313
EM43	Hadrian South Field (Gulf of Mexico)	BD	1	-173.9	0.12	-60.40	0.004	5.9	0.26	34	8	**42**	43
EM44	Hadrian South Field (Gulf of Mexico)	BD	1	-173.7	0.15	-58.05	0.005	5.5	0.24	48	8	**48**	78
Q-Y-1	Qaidam Basin (China)	BD	1	-228.6	0.14	-69.33	0.004	5.4	0.25	49	7	**19**	1663
Q-Y-2	Qaidam Basin (China)	BD	1	-228.6	0.12	-69.76	0.004	5.4	0.25	50	9	**26**	905
Q-Y-3	Qaidam Basin (China)	BD	1	-224.1	0.12	-71.72	0.004	5.4	0.25	49	9	**29**	1648
Q-T-1	Qaidam Basin (China)	BD	1	-220.2	0.12	-71.74	0.005	5.5	0.24	48	8	**29**	1644
Q-T-2	Qaidam Basin (China)	BD	1	-228.2	0.15	-69.41	0.004	5.1	0.25	61	8	**62**	908
Q-T-3	Qaidam Basin (China)	BD	2	-231.7	0.01	-69.43	0.056	4.4	0.49	87	22	**31**	554
Q-S-1	Qaidam Basin (China)	BD	2	-229.2	0.07	-69.87	0.050	4.7	0.25	77	10	**31**	908
Q-S-2	Qaidam Basin (China)	BD	4	-230.5	0.12	-69.78	0.029	5.0	0.28	65	11	**56**	999
Q-S-3	Qaidam Basin (China)	BD	3	-236.6	0.06	-68.29	0.074	4.3	0.41	95	19	**73**	427
EM45	Milk River Formation (Canada)	BD	1	-246.0	0.11	-67.17	0.005	4.9	0.24	69	9	**16**	
EM46	Milk River Formation (Canada)	BD	1	-238.8	0.12	-68.66	0.004	4.8	0.21	74	9	**16**	

Supplementary Table: Isotopic composition of previously unpublished methane samples discussed in the manuscript

PT-11359-23	Experimental	PE	1	-365.1	0.13	-43.30	0.007	1.0	0.38	450	114	*300*
PT-11359-24	Experimental	PE	1	-348.2	0.11	-43.38	0.005	2.1	0.24	253	28	*320*
PT-11359-25	Experimental	PE	1	-343.5	0.12	-43.52	0.004	2.0	0.21	261	26	*320*
PT-11359-26	Experimental	PE	1	-318.4	0.12	-43.42	0.004	1.4	0.25	353	48	340
PT-11359-27	Experimental	PE	1	-296.1	0.13	-42.96	0.005	1.3	0.24	377	52	360
HP 3830	Experimental	PE	1	-318.6	0.13	-39.71	0.006	0.8	0.27	500	98	*390*
HP 3828	Experimental	PE	1	-327.7	0.15	-43.48	0.006	1.3	0.25	385	56	*330*
HP 3734	Experimental	PE	1	-308.7	0.12	-39.52	0.004	0.3	0.24	794	237	*390*
HP 3729	Experimental	PE	1	-327.6	0.11	-44.92	0.004	1.2	0.25	391	56	*360*
HP 3831	Experimental	PE	1	-310.2	0.12	-33.42	0.005	1.0	0.24	448	71	*415*
HP 3730	Experimental	PE	1	-320.0	0.13	-44.11	0.004	1.1	0.24	432	65	*330*
HP 3733	Experimental	PE	1	-318.1	0.12	-44.95	0.004	1.7	0.25	311	40	*360*

Type Codes: HV: Hydrothermal/Volcanic; Z: Serpentinization; T: Thermogenic; C: Conventional; A: Associated; S: Seep Derived; N: Non-Associated; U: Unconventional; M: Mixture; BD: Deep Subsurface Microbial; PE: Pyrolysis Experiment

Bold: Measured or Estimated Well Temperature (See Section 2.4); *Italics: Experimental Temperature*